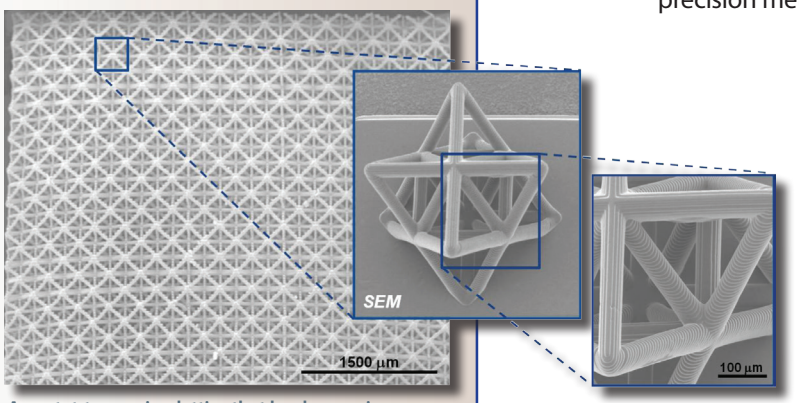
Advanced Manufacturing

Lawrence Livermore National Laboratory

Microarchitected, soft, mechanical energy absorbing material 3D printed with a custom Direct Ink Writing (DIW) system.

A rocket motor 3D printed in a single piece, complete with internal cooling passages. This stainless steel component was fabricated using a laser powder melting additive manufacturing machine.



An octet-truss microlattice that has been micro-architected with ultralow density and ultrahigh stiffness and strength.

Manufacturing is undergoing a dramatic transition enabled by new techniques, new materials, and high-performance computing. One of the epicenters of this transition is within the Advanced Manufacturing labs at Lawrence Livermore National Laboratory.

At LLNL, our efforts in manufacturing science range from developing new additive manufacturing processes to carbon fiber composites. We span size scales from micrometer and nanometer-sized structures to meter-sized components for national security applications, and our materials sets range from polymers to metals and ceramics. Our work is underpinned by deep scientific understanding gained through high-performance computing, modeling, and simulation.

LLNL is developing solutions to a wide range of problems, in some cases cutting costs by 80% and manufacturing footprint and production time by 90%. And, we do all this while creating more-capable products. Additionally, by combining aggressive program deliverables and strategic institutional R&D investments, we are able to maintain a unique capability mix that includes:

- Precision manufacturing
- Computational capabilities
- Material science and engineering

This mix enables us to engage across a broad spectrum of advanced manufacturing challenges.

Unique Expertise

Simulation

- Extensive capabilities in material simulation, process modeling, and predictive performance modeling; multiscale, multiphysics modeling

Synthesis

- Tailored synthesis of nanomaterials, other custom feedstocks, and source materials

Characterization

- Broad competencies in material characterization and testing, microscopy, precision metrology, nondestructive evaluation, and prototype testing

Manufacturing

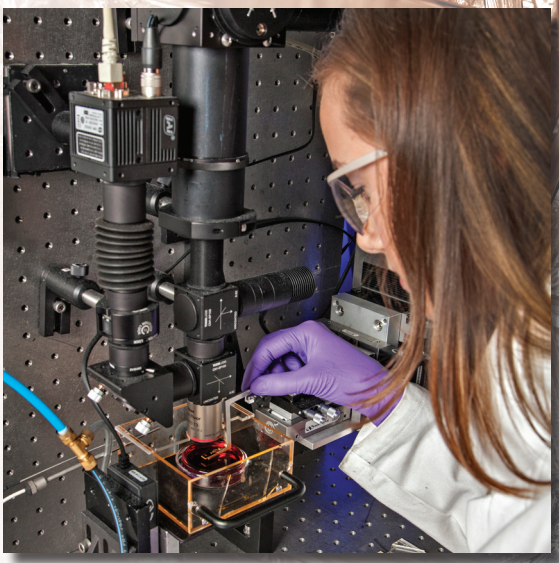
- Precision machining and assembly of complex parts
- Unique microfabrication infrastructure for exploring and developing custom processes
- Growing array of custom and commercial additive manufacturing tools
- Fiber composite fabrication of large prototype parts

Micro- and Nanotechnology

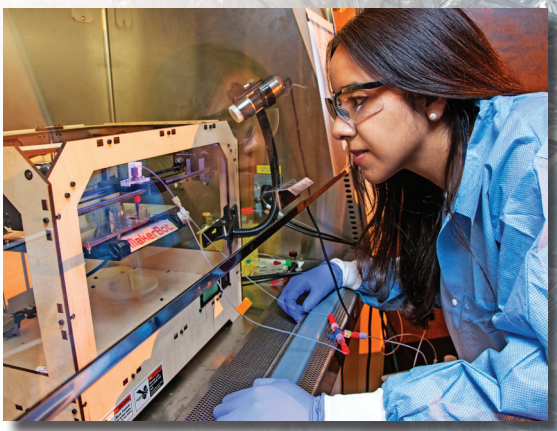
- Materials, devices, instruments, and systems that require micro- or nanofabricated components, including micro-electromechanical systems (MEMS), electronics, photonics, micro- and nanostructures, and micro- and nanoactuators

Unique Infrastructure

- Additive manufacturing (commercially available) capabilities in both plastics and metals
- Custom-developed additive manufacturing capabilities for micro-/nanoscale features and special materials
- Carbon fiber composites manufacturing facility
- Large-scale conventional manufacturing facilities
- Special materials manufacturing
- Electronics fabrication
- MEMS and photonics fabrication
- Class-100 clean room
- High-performance computing capabilities
- Chemical, biologic, radiologic, and nuclear sensors and detectors



Operating a microstereolithography system.



Conducting bioprinting operations.

Mission Areas

Stockpile Stewardship

- Sensors, replacement materials, functionalized components, and fast diagnostic systems

Inertial Confinement Fusion

- Next-generation laser target materials and fabrication techniques; complex targets

Energy Security

- Energy storage devices, unique fracking proppants, and tailored materials for carbon sequestration

Intelligence

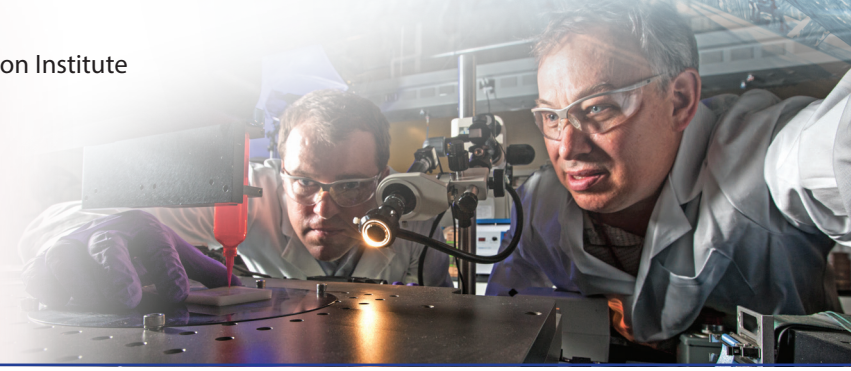
- Chemical, biologic, radiologic, and nuclear sensors and detectors

Sponsors and Collaborators

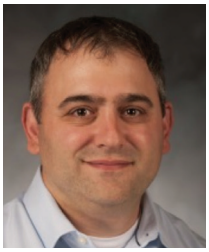
LLNL Laboratory Directed Research and Development
National Nuclear Security Administration
Defense Advanced Research Projects Agency
U.S. Air Force
U.S. Department of Energy
America Makes – National Additive Manufacturing Innovation Institute
Industrial partners

Academic Alliances

Massachusetts Institute of Technology
Harvard University
University of Illinois at Urbana-Champaign
UCLA
Worcester Polytechnic University



Capability Leader



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Chris is the Director of the Center for Engineered Materials, Manufacturing and Optimization in the Engineering Directorate at LLNL. This center focuses on developing new micro- and nanoscale additive manufacturing techniques that span material classes from polymers to metals and ceramics. The center also designs and fabricates architected materials with unique properties such as negative thermal expansion and negative stiffness.

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